FLOTSAM AND JETSAM OF CANTON ATOLL, SOUTH PACIFIC

Otto & Isa Degener

Canton, a Pacific Ocean atoll lying between latitude 2° 46' and 2° 52' S., and longitude 171° 37' and 171° 44' W., is the most northern of eight low coral islands comprising the Phoenix Group. Resembling a pork chop in shape, it is about eight miles long, and has its longer axis lying roughly from its narrower eastern end to its four miles wide western end (fig. 1). The atoll consists of a rim 150 to 1,800 feet wide enclosing a shallow lagoon of about 25 square miles. The greatest elevation of the island is twenty feet.

Evidently built around a volcanic core, the atoll consists mainly of the calcareous skeletons and shells of invertebrates, fragments of coralline algae, and a few vertebrate skeletons. All have been comminuted into sand and powder, andor cemented into vast stretches of calcite. These last rim the island and are worn smooth by the waves washing back and forth over them with scouring material. The dry atoll rim of calcite fragments, sand and powder is more or less glued together by felt-like or gelatinous films of numerous genera of blue-green algae (Degener & Degener 1959). Bird excrement, hardly guano, accumulates under the rookeries of booby and frigate birds nesting preferably on scaevola bushes (Murphy et al., 1954; fig. 2). Rare areas of humus may be found in patches of forest, the result not only of fallen twigs and leaves, but from accumulated excrement of the terrestrial hermitcrab Coenobita perlatus. Some of this earth, an estimated collection of 1,000 years, may be four inches deep.

The atoll was of little importance until Pan American World Airways began to use it as a refueling station in 1939 for aircraft on Honolulu-Auckland flights. As both Great Britain and the United States laid claim to this flat area, the controversy was amicably settled April 6, 1939 by agreement to administer the atoll jointly as a condominium for fifty years and "thereafter until such time as it may be modified or terminated by mutual consent." With outbreak of World War II, Canton became the hub of Pacific air movement by United States Military Forces. In 1942, with 1,143 Army personnel stationed there, it was used for antisubmarine search and photographic reconnaisance missions. A year later it was the main base for the conquest of the Gilbert Islands from the Japanese. By 1950 commercial activity was at its zenith, with four major airlines involved and a resident force of about 300 Americans and British.

With continuous improvement in airplanes, the importance of Canton as a refueling station waned. The last scheduled commercial stop was in 1959. That same year the National Aeronautics and Space Administration (NASA) selected Canton as Project Mercury Tracking

Station Number 11, and for a few years until 1966 to support the astronauts in Project Gemini. During 1968 the Government of American Samoa was permitted to salvage whatever it wanted from deactivated installations. In 1970 the atoll became a Space and Missile Test Center serviced by United States personnel, many being Samoans (Bickett 1971 for details and references).

As Botanical Consultant for Canton Atoll for the Civil Aeronautics Administration (CAA), Otto Degener explored and worked on the atoll for a week in July 1950 and for six weeks in April-May 1951. Isa Degener and he then continued study of the atoll for about three weeks in February-March 1958.

Canton has been under the scrutiny of many scientists practicing diverse disciplines. According to the entomologist van Zwaluwenburg (1942) on Canton "Between December 1940 and February 1941 there were some weeks of strong westerly winds which attained a velocity of 55 knots. The effect of these prolonged gales on the normal ocean currents, though temporary, must have been considerable. Drift-borne seeds were absent or at least inconspicuous on the Canton beaches the year before, but by August they were a striking feature of the shore line everywhere. It is assumed that their presence is a result of the gales of the previous winter." He forthwith mentions what he considers to be Myristica sp., Entada scandens, Inocarpus edulis, Mucuna spp. (4), Caesalpinia crista, Canarium sp., Barringtonia speciosa, Terminalia catappa, Cerbera odollam, unidentified spp. (3), Aleurites moluccana, Pandanus sp., and viable Cocos. "Seeds of many of the species listed had sprouted after stranding. Between 35 and 50 coconut sprouts were estimated to be still present in September along the entire 27-mile perimeter of the island, but these were only a fraction of the total number of coconuts cast up. Some of the hazards attending the survival of seedling plants from drift seeds are obvious: Coenobita olivieri Owen [C. perlatus] shred the husk of coconuts and eat out the contents of the sprouted nuts; flood tides drench many seedlings with sea water; in at least one case high water buried a sprouted palm deep in sand. So the complete failure of any of the above named species to become established on Canton in the past - - - is not surprising when, to the hazards already mentioned, are added the inevitable recurrent shortages of rain."

When we visited the island in the winter of 1957-58, we similarly found on its beaches great accumulations of floated debris, mostly wood (fig. 3), fruits and seeds (fig. 4) reminiscent of the situation mentioned by van Zwaluwenburg. Such objects, often with superficial scrutiny, can be identified to the genus; and, particularly fruits and seeds, to the species. For the specific determination of thousands of puzzling Canavalia seeds, however, considerable space in a garden is needed to raise them so that the plants can be identified by study of flowers, legumes and seeds. We lacked such space. Nevertheless, one questionable Canton seed collected in 1958 and

planted in our garden at Mokuleia Beach, Oahu, Hawaii, is now a 50 foot tall Hernandia peltata Meissn. Though hundreds of seeds of Erythrina were collected on Canton, only a few were planted in the garden. One, allowed to flower and fruit, was E. variegata var. orientalis (L.) Merr. Becoming too large and beginning to buckle a house foundation, it was chopped down. Its larger limbs and its trunk segments, rolled to the beach for disposal, soon struck root and sprouted. This variety evidently can colonize isolated islands not only by seed but by trunk fragments. With facilities to plant a thousand Canton seeds of Erythrina and a thousand of the very variable seeds of Canavalia, many as yet undescribed taxa might have been discovered.

As many representative propagules were collected, chiefly along the north shore, as the expense of shipping them home permitted. Numbered voucher specimens have been deposited at the New York Botanical Garden (NY) with unicates, and similar collections at the University of Massachusetts (MASS), Berlin (B), Kew (K), Bishop Museum (BISH), Arnold Arboretum (A), Cornell (BH, CU), Geneva (G), Munich (M), Smithsonian (US), St. Louis (MO), United States Department of Agriculture (USFS), Vienna (W) and elsewhere. Many of these specimens have been so efficiently filed away taxonomically that it is impracticable to reassemble them to ascertain their herbarium numbers. We succeeded in identifying most of the disseminules ourselves. Dr. R. Melville independently identified many of the numbers we had identified and, in addition, many unknown to us; and so did likewise Dr. Charles R. Gunn, Mr. John V. Dennis and Miss M.H. Stone.

Intrigued by a 1968 article by Dr. Gunn about stranded seeds and fruits along Florida's shore, we dusted off our old notes, photographs and the few specimens remaining to us. We then prepared the present paper, with editorial suggestions from Gunn and Dennis. Two companion papers should follow: one, under authorship of Degeners, Gunn and Dennis, should describe and illustrate the Canton Atoll material in some detail; while the other, under authorship of Gunn and Dennis, might concentrate on wind and ocean currents in the Pacific, and buoyancy.

The following lists what we believe we collected on Canton. As the identification of certain propagules - especially of Canavalia, Erythrina, Mucuna, Terminalia - is difficult or impossible unless these can be grown to produce identifiable flowers, the list is a tentative one. Some of the specimens bear Degener & Degener collection numbers.

Cycadaceae: Cycas circinalis L., D. & D. 24,668.
Podocarpaceae: ?Podocarpus elongata L'Herit.
Pandanaceae: Pandanus spp.
Palmae: ?Borassus, D. & D. 24,625; Cocos nucifera L.; Nypa frutescens Wurmb., D. & D. 24,692.
Taccaceae: Tacca leontopetaloides (L.) Kuntze.
Casuarinaceae: Casuarina equisetifolia Forst.

Fagaceae: Quercus bennettii Miq., D. & D. 24,683.
Olacaceae: ?Ximenia americana L.
Cassythaceae: Cassytha filiformis L.
Hernandiaceae: Hernandia nymphaeifolia (Presl) Kubitski; H. peltata Meissn., andor some similar species, D. & D. 24,697, 24,702.
Chrysobalanaceae: Parinari glaberrima Hassk.

Leguminosae: Canavalia cathartica Thouars, D. & D. 24,675; C. micropiper (DC.) Piper; C. spp., many taxa, some probably new; Cynometra sp.; Dioclea reflexa Hook. f., D. & D. 24,684, 24,975; D. violacea Mart., D. & D. 24,671; D. spp.; Entada phaseoloides (L.) Merr., andor related spp., D. & D. 24,628, 24,629; Erythrina variegata var. orientalis (L.) Merr., andor other spp., D. & D. 24,669; Guilandina crista (L.) Small; Intsia (Afzelia) bijuga (Colebr.) Kuntze, D. & D. 24,687; Mucuna gigantea (Willd.) DC., D. & D. 24,670; M. cf. gigantea, D. & D. 24,682; M. ?kraikei Warb., D. & D. 24,681, 24,974; M. spp. D. & D. 24,667; Pongamia pinnata (L.) Merr.; Sophora tomentosa L., D. & D. 24,706; Strongylodon lucidus (Forst. f.) Seem. (or perhaps S. pseudolucidus), D. & D. 24,691.
Burseraceae: Canarium cf. decumanum Gaertn., D. & D. 24,620; C. spp., D. & D. 24,620 ; C.mehenbethene Gaertn., D. & D. 24,626; C. spp., D. & D. 24,676, 24,694.
Meliaceae: Xylocarpus (Carapa) moluccensis (Lam.) Roem., (Globular fruit always with calcareous tunnels of Teredo clava.), D. & D. 24,665.
Euphorbiaceae: Aleurites moluccana Willd., D. & D. 24,686; Aleurites sp. nov.? with walnut-marked seed, D. & D. 24,627; Hevea brasiliensis (HBK) Muell-Arg.; Hippomane mancinella L., D. & D. 24,699.
Anacardiaceae: Spondias cytherea Sonner., (or perhaps doubtfully distinct S. dulcis), D. & D. 24,672.
Rhamnaceae: Colubrina cf. asiatica Brongn. (Seeds rather small.)
Tiliaceae: Triumfetta procumbens Forst.
Malvaceae: Pariti tiliaceum (L.) Britt.; Thespesia populnea (L.) Soland.
Bombacaceae: ?Ochroma sp.
Sterculiaceae: Heritiera littoralis Dryand.; Melochia sp.
Guttiferae: Calophyllum inophyllum L., D. & D. 24,680.
Flacourtiaceae: Pangium edule Reinw., D. & D. 24,677.
Sonneratiaceae: Sonneratia sp.
Lecythidaceae: Barringtonia speciosa (L.) Kurz.
Combretaceae: ?Lumnitzera; Terminalia cf. catappa L., D. & D. 24,673; T. spp., D. & D. 24,668, 24,674, ?24,975.
Sapotaceae: Palaquium sp.; Sapotaceae?, D. & D. 24,693.
Apocynaceae: Cerbera manghas L.
Convolvulaceae: Ipomoea pes-caprae var. emarginata Hall. f., D. & D. 24,679.
Boraginaceae: Cordia subcordata Lam., D. & D. 24,578; Messerschmidia argentea (L. f.) Johnston.
Verbenaceae: Clerodendrum inerme (L.) Gaertn.

Rubiaceae: Guettarda speciosa L., D. & D.24,678; Morinda citrifolia L.
Apocynaceae: Ochrosia cf. oppositifolia (Lam.) K. Schum., D. & D. 24,698.
Goodeniaceae: Scaevola sp.
Compositae: Wedelia biflora (L.) DC.

Because drift logs had housed shipworms of various genera (Banksia sp.; Martensia spp.; Teredo bensoni, T. clava, T. samoaensis) and some goose barnacles (Lepas anatifera), nearly a hundred wood samples were collected. These were shipped to the late Dr. Charles H. Edmondson for his studies of wood-fouling organisms. Even logs of balsa, Ochroma pyramidale (Cav.) Urb., an American species, were found. These were conspicuous from other dicotyledonous wood by being practically free of shipworms and entirely free of goose barnacles. This freedom of organisms on floating balsa is due more to the remarkable lightness of the wood than to any other factor. Balsa wood practically floats on the ocean surface and, with the slightest breeze, the wet surface is lifted out of the water and exposed to the drying air. Hence this wood, as a whole, is simply too dry to sustain marine organisms.

In chopping drift logs for the pallets and shells, so necessary for the identification of shipworms, we came across several colonies of termites, such as Coptotermes formosana hitherto unrecorded from Canton. These insects appeared to have drifted to the atoll. It seems reasonable that wood boring insects can survive ocean transportation within a tree trunk as time is not always sufficient for wood to get waterlogged through and through. Though not in a position to offer proof, it is possible for a knothole in a tree to seal over so that the enclosed cavity will house propagules of animals and plants; eggs, cysts, the aestivating or hibernating organisms themselves, spores, seeds, fungus hyphae, etc. Such a drifted log, cast upon a sun-scorched beach and there decaying, would eventually liberate such propagules into such an unfavorable environment that most would succumb. But another factor promoting survival and colonization not only for "knothole migrants" but for drift fruits and seeds enters the picture.

Living at the beach on northern Oahu, Hawaiian Islands, and having had our home and garden devastated by the tsunami or "tidal waves" of April 1, 1946 and March 9, 1957, we were overwhelmed by one truth. Tsunami are frequent and of enormous effect, pushing drift of all kinds a few feet to hundreds of feet inland from the inhospitable beach to often humus soil and loam. Such action of the tsunami is on a wholesale scale, entire coastlines usually totaling thousands of miles being affected.

For some years after a tsunami we eradicated seedlings of the wild, endemic naupaka kai (Scaevola sericea var. fauriei (Lévl.) Deg. & Deg.) and of the exotic seagrape (Coccoloba uvifera (L.) L.) that

continued to sprout in flower beds 200 to 300 feet inland from the stands along the beach. Similarly, on the south shore of Oahu, some years after the tsunami of 1946, Mr. Walter Bayer showed us healthy plants of the locally rare endemic taxon of Colubrina asiatica (L.) Brongn., that had sprouted from the elevated windrow of debris cast up in his garden.

Anyone who has seen the hard-shelled eggs of geckos glued in holes and crevices of coconut and other logs along the beach will have an explanation - perhaps the true one - for the wide distribution of such reptiles.

Islands surrounded by great deeps with icy cold water even in the tropics, are beyond reach of most nonswimming, aquatic organisms unless they have a pelagic stage of some duration in their life. If these do not reach the completely isolated island via floating logs or larger propagules, a rare but effective means of transportation may be available. In studying the beaches of Canton we have come across quantities of gray to almost black blocks of pumice, and occasionally the shells of the pearly nautilus and the cuttlebone of the octopus. A random glance at dark pumice and more careful inspection of pale nautilus and cuttlebone occasionally discloses the white of coral and the calcareous housing of marine worms. Such types, and many others, may well have reached Canton waters mature enough to reproduce their kind before being washed upon the beach to die. We wish to emphasize that electric light bulbs, other waste artifacts and garbage of Caucasian and Oriental civilizations, so common to many beaches, are conspicuously absent on Canton. Outstanding artifacts were several outrigger canoes and a primitive paddle. Residents claim that one canoe, definitely hollowed out with a stone adz, is of African origin. Study of a wood fragment, never collected, would have decided such claim.

They are just bugs (Hemiptera, Family Vallidae); but to us, pathetic ones all the same. Just beyond where the strongest waves lap the beach, among foam, sand and coral blocks of various sizes, clumsily and weakly hop exhausted marine waterstriders (Halobates micans). They are black above, perhaps for desired warmth; pale bluish below to be camouflaged against attack by hungry fish fry looking upward from below. They are only a few millimeters long. Agile skaters on the surface film of ocean water, like their relatives on fresh water of American brooks and ponds, they are helpless when thoroughly wetted during a storm or when blown unsuspectingly by the trade winds and swept by the breakers onto shore. They are out of their element and here they die. Though living on the vast expanse of the ocean, they are no more water creatures than are the frigate birds flying overhead. This insect, to survive from generation to generation, must find a chance piece of driftwood, seed, pumice or even floating feather upon which to lay its eggs: while the bird and the sea turtle must find an island like Canton to lay theirs. These waterstriders, we believe, had been swept along the surface of the ocean like the fruits and seeds by gale force winds rather than washed by ocean currents to pile up on the beach.

Due to a spell of rainy weather germination of more or less salt freed seeds were so successful that the beach showed a narrow, faint line of green extending for many miles, a condition unknown to any resident of the time. In this line of drift not a single Canton species was noticed except Cassytha filiformis, Triumfetta procumbens and Cordia subcordata. As these propagules were wave worn, we believe them not of local origin.

The sea hearts (Entada phaseoloides s.l.), with large expanded cotyledons, a few leaves and a slender stem elongating vainly for a support to climb, were already beginning to suffer in February from the strong drying salt breeze. Not one became established. Thousands upon thousands of seedlings of the beach morningglory (Ipomoea pes-caprae var. emarginata) with stiff, thick, green, deeply notched cotyledons horizontally akimbo, were being daily eaten by the hermitcrab (C. perlatus), known in the vernacular as "Bernard." Various Mucuna species, probably rich in the poison L-dopa, were germinating merely to fall prey to these hungry hermitcrabs. Of the myriad viable seeds that braved the ocean for unknown weeks and months without succumbing before landing on Canton shores, we failed to see a single successful introduction. This atoll simply does not offer conditions fit for survival of phanerogams excepting for the trees Cordia subcordata and Messerschmidia argentea (fig. 5), the vines moonflower (Calonyction tuba) and lovevine (Cassytha filiformis), and thirteen other shrubs and herbs (fig. 6). These natives are described in Degener & Gillaspy (1955) and Degener & Degener (1958). Should certain kinds of seeds be washed farther inland by a tsunami where shelter and favorable soil conditions would permit such adventives to establish themselves, they would be soon destroyed by the hermitcrabs. These congregate under bushes and trees during the heat of the day, while at other times they roam over the atoll greedily scavenging in search of food (figs. 7, 8).

Of individuals who have been on Canton, we wish to acknowledge the help of Island Manager Edwin Gillaspy and Mrs. Gillaspy; Mr. & Mrs. Albert Lincoln, well-informed residents and malacologists; and Dr. L.H. MacDaniels, who analysed the soil and water of Canton many years ago. For additional information touching diverse aspects of the atoll, the reader is advised to consult Murphy, Niedrach & Bailey (1954), and their bibliography compiled by E.H. Bryan, Jr., of about seventy items published between 1862 and 1954: and the following bibliography of additional pertinent items:

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The above references apply to Canton Atoll in the Pacific; the following applies to Florida, off the Atlantic:

Gunn. C.R. (March-April) 1968. Stranded Seeds and Fruits from the Southeastern Shore of Florida. N.Y. Bot. Gard. Journ. 43-54.

Fig. 1. Canton Atoll (After Hatheway 1955)

Fig. 2. Frigate bird rookery amid scaevola bushes

(overleaf, following page)

Fig. 3. Driftwood and barringtonia fruits, etc.

Fig. 4. Fruits, seeds and seedlings

Fig. 5. Messerschmidia argentea, a favorite shade tree for the terrestrial hermitcrab (C. perlatus) to rest during heat of day (Degener & Rasche photo)

Fig. 6. Native phanerogam vegetation consists of seventeen species only: Digitaria, Eragrostis, two of Lepturus, Boerhavia, Sesuvium, Portulaca, Cassytha, Tribulus, Suriana, Triumfetta, Sida, Pemphis, Calonyction, Cordia, Messerschmidia and Scaevola

(opposite page)

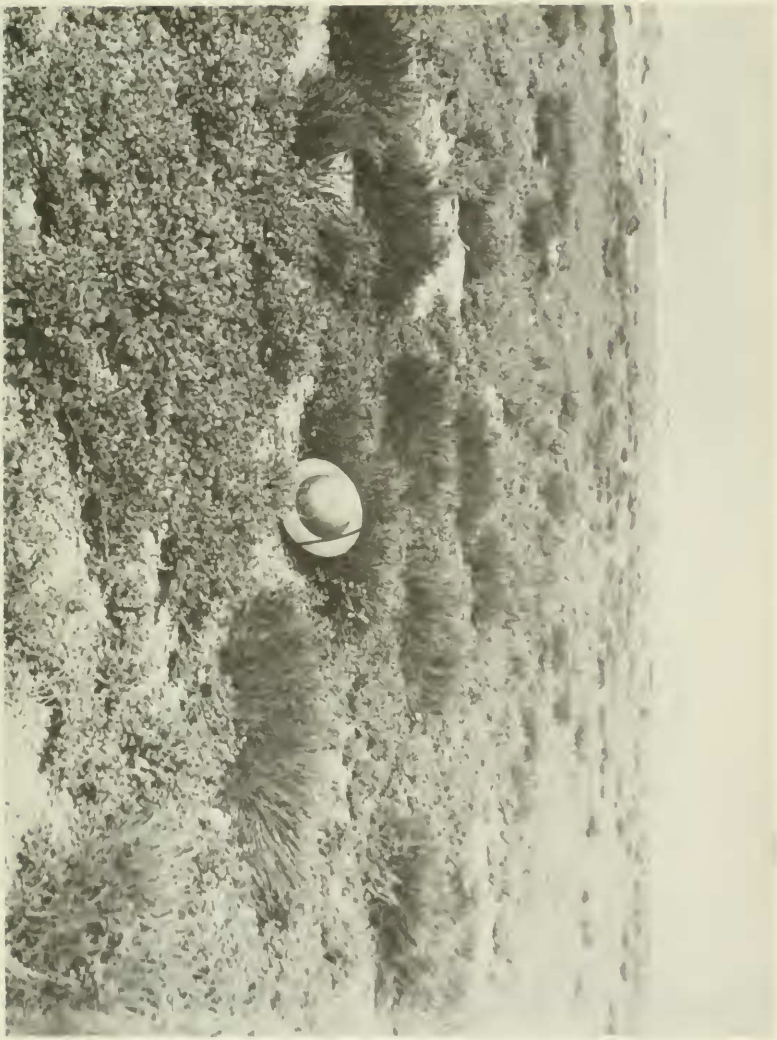

Fig. 7. Hermitcrabs enjoying their siesta (Degener & Rasche photo)

Fig. 8. Hermitcrabs roaming over atoll in search of food